APPLICATION

FOR

UNITED STATES LETTERS PATENT

PATENT APPLICATION

SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

Be it known that E. Marlowe Goble of 5 West Blair Road, Alta, Wyoming 83452 has invented certain improvements in METHOD AND APPARATUS FOR RECONSTRUCTING A LIGAMENT, of which the following description is a specification.

METHOD AND APPARATUS FOR RECONSTRUCTING A LIGAMENT

Reference To Pending Prior Patent Application

This patent application claims benefit of pending prior U.S. Provisional Patent Application Serial No. 60/237,817, filed 10/03/00 by E. Marlowe Goble for METHOD AND APPARATUS FOR RECONSTRUCTING A LIGAMENT, which patent application is hereby incorporated herein by reference.

Field Of The Invention

This invention relates to medical procedures and apparatus in general, and more particularly to medical procedures and apparatus for reconstructing a ligament.

Background Of The Invention

A ligament is a piece of fibrous tissue which connects one bone to another.

Ligaments are frequently damaged (e.g., detached or torn or ruptured, etc.) as the result of injury

and/or accident. A damaged ligament can impede proper motion of a joint and cause significant pain.

Various procedures have been developed to repair or replace a damaged ligament. The specific procedures used depend on the particular ligament which is to be restored and on the extent of the damage.

One ligament which is frequently damaged as the result of injury and/or accident is the anterior cruciate ligament (ACL). Looking now at Fig. 1, the ACL 5 extends between the top of the tibia 10 and the bottom of the femur 15. A damaged ACL can cause instability of the knee joint and cause substantial pain and arthritis.

Numerous procedures have been developed to restore the ACL through a graft ligament replacement. In general, and looking now at Fig. 2, these ACL replacement procedures involve drilling a bone tunnel 20 through tibia 10 and up into femur 15. Then a graft ligament 25, consisting of a harvested or artificial ligament or tendon(s), is passed through

the tibial portion 30 of tunnel 20 (sometimes referred to as the "tibial tunnel"), across the interior of the joint, and up into the femoral portion 35 of tunnel 20 (sometimes referred to as the "femoral tunnel"). Then a distal portion of graft ligament 25 is secured in femoral tunnel 35, and a proximal portion of graft ligament 25 is secured in tibial tunnel 30.

Description Of The Present Invention

There are numerous ways in which graft ligament 25 may be loaded into bone tunnel 20 and then secured in position.

The present invention is directed to a new method for positioning a graft ligament 25 in bone tunnel 20 and for securing the graft ligament in position, and to new apparatus for use in the same.

More particularly, and looking now at Fig. 3, after bone tunnel 20 (consisting of tibial tunnel 30 and femoral tunnel 35) have been drilled, a drill guide 40 is inserted into the bone tunnel, i.e., the drill guide has its endosteal guide 45 passed up

tibial tunnel 30, across the interior of the knee joint, and then up femoral tunnel 35. Then an anterolateral portal is made on the anterior border of the IT band, and an angled tunnel 50 is drilled from the periosteum to the proximal end of femoral tunnel 35. Thus, angled tunnel 50 opens on, and communicates with, femoral tunnel 35. In this respect it should be appreciated that drill guide 40 is essentially a cross-pin drill guide of the sort well known in the art, except modified so as to enable the angled tunnel 50 to be drilled at an acute angle (e.g., 45 degrees) to the axis of femoral tunnel 35. If desired, drill guide 40 can be set so as to always drill the angled tunnel 50 at the same angle (e.g., 30 or 45 or 60 degrees, etc.), or the approach may be straight, i.e., aligned with the femoral tunnel (e.g., at 0 degrees), or drill guide 40 can be configured so as to be adjustable, whereby the surgeon can select the specific angle of angled tunnel 50. By way of example but not limitation, some details regarding the

construction of one preferred form of drill guide 40 is shown in Figs. 4-6.

Looking next at Fig. 7, after angled tunnel 50 is drilled, the drill and barrel guide are removed from drill guide 40, and the drill guide is rotated about the axis of bone tunnel 20 so as to swing the drill guide's head away from the entrance to angled tunnel 50, whereby to provide convenient access to the entrance of angled tunnel 50.

Looking next at Fig. 8, a braided wire suture 55 is inserted down angled tunnel 50 and "grabbed" by the distal end of endosteal guide 45. To this end, the endosteal guide may include some sort of grippers at its distal end, or the end of the wire suture may include a loop at its distal end and the endosteal guide may include some sort of hook at its distal end, or the end of the endosteal guide may include some sort of loop at its distal end and the end of the wire suture may include some sort of hook at its distal end, etc. Alternatively, endosteal guide 45 may be cannulated so as to permit grippers or a hook to be

passed down the interior of the endosteal guide to grab the distal end of the wire suture. In any case, the endosteal guide and wire suture are configured so as to permit the distal end of the endosteal guide to connect up with the distal end of the wire suture.

Referring next to Fig. 9, once the distal end of endosteal guide 45 is connected with the distal end of wire suture 55, a cannulated screw 60 is slid down the wire suture and screwed into angled tunnel 50. This can be done by using a cannulated driver (not shown in Fig. 9) of the sort well known in the art. Cannulated screw 60 is screwed into femur 10 until the head of the screw contacts the periosteum so that the head of the screw does not stand proud above the bone. Cannulated screw 60 essentially acts as a sort of liner for angled tunnel 50, providing a bearing surface for wire suture 55 so as to prevent the wire suture from cutting into femur 15 as the wire suture is moved through angled tunnel 50, as will hereinafter be discussed.

Next, and looking now at Fig. 10, drill guide 40 is withdrawn from the surgical site. As this occurs, the drill guide's endosteal guide 45 is removed from bone tunnel 20, causing wire suture 55 to be pulled down femoral tunnel 35, across the interior of the knee joint, down tibial tunnel 30 and then out the bottom end of the tibial tunnel.

Then, as shown in Fig. 11, the graft ligament 25, e.g., one or more strands of a hamstring tendon, is attached to the distal end of wire suture 55. In the case where the graft ligament comprises one or more strands of hamstring tendon, such attachment can be easily accomplished by forming a loop at the lower end of wire suture 55 and then passing the tendon strand(s) through the loop, in the manner shown in Fig. 11.

Next, as shown in Fig. 12, wire suture 55 is pulled proximally so as to tow graft ligament 25 up bone tunnel 20 until the distal end of the graft ligament is positioned in femoral tunnel 35 and the proximal end of the graft ligament is positioned in

tibial tunnel 30. Then a crimp 65 is attached to wire suture 55 adjacent to cannulated screw 60 so that engagement of crimp 65 with cannulated screw 60 will prevent the wire suture from being pulled back in the tibial direction. Next, graft ligament 25 is tensioned by pulling the proximal end of the graft ligament in the proximal direction, and then the proximal end of the graft ligament is fixed to the tibia in ways well known in the art. If desired, the proximal end of cannulated screw 60 can have a modest recess therein so as to receive crimp 65 when the ligament is tensioned, whereby to keep the crimp from standing proud above the femur. Alternatively, the bone screw can be eliminated, utilizing only the crimp on the wire to prevent distal migration. Finally, the end of wire suture 55 proximal to crimp 65 is trimmed off, thus effectively completing the ACL reconstruction procedure.

In the foregoing description, and in Figs. 11 and 12, graft ligament 25 was discussed in the context of comprising one or more strands of hamstring tendon.

However, it should also be appreciated that graft ligament 25 may comprise other constructs as well. Thus, for example, graft ligament 25 may comprise one or more bone blocks attached to a tendon (e.g., a so-called "bone-tendon-bone" graft), or a totally artificial prosthesis, etc.

By way of example but not limitation, Figs. 13 and 14 shown a bone-tendon-bone graft being towed into position within bone tunnel 20. In this case, wire suture 55 may be attached to the leading bone block 70, e.g., by passing the wire suture through one or more holes formed in the bone block and making it fast. If desired, a second wire suture 75 may be attached to the trailing bone block 80 so as to fasten the trailing end of the ligament graft to tibia 10 in ways well known in the art.

It should be appreciated that the aforementioned procedure and apparatus may be modified without departing from the scope of the present invention.

Thus, for example, and looking now at Fig. 15, in one alternative reconstruction procedure, after angled

tunnel 50 has been drilled, drill guide 40 is completely removed from the surgical site. Then a wire suture 55, preferably having a loop 83 at its distal end, is passed down angled tunnel 50 until the wire suture begins to pass into the top end of femoral tunnel 35. Next, a suture grasper 85 passed up bone tunnel 20 until the distal end of the suture grasper is positioned adjacent to the distal end of wire suture 55, whereupon the suture grasper can be used to pick up the distal end of wire suture 55 and draw the wire suture down femoral tunnel 35, across the interior of the knee joint, down tibial tunnel 30 and finally out the front of tibia 10, as shown in Fig. 16. The cannulated screw 60 can then be mounted on the proximal end of wire suture 55, the cannulated screw screwed down into the periosteum, the distal end of wire suture 55 fastened to the graft ligament, the wire suture retracted so as to tow the graft ligament up bone tunnel 20 and into position, the crimp 65 applied to the wire suture, and then the graft

ligament made fast to the tibia, all in substantially the same manner as previously described.

And in another alternative reconstruction procedure, cannulated screw 60 and crimp 65 may be replaced by an alternative construction. More particularly, and looking now at Fig. 17-19, a cannulated screw 90 and an associated threaded collet 95 are shown. Cannulated screw 90 has the usual external threads 100 (Fig. 17) and central bore 105 (Fig. 18); however, cannulated screw 90 also has a threaded counterbore 110 (Fig. 18) terminating, intermediate the cannulated screw, in a smooth tapered section 115. Correspondingly, threaded collet 95 comprises a leading tapered section 120 (Fig. 17), a trailing threaded section 125, and a central bore 130 (Fig. 18). The collet's leading tapered section 120 is slit, whereby the threaded section 120 can be forced radially inward so as to close down the diameter of the collet's central bore 130. Cannulated screw 90 and threaded collet 95 are sized so that the threaded collet 95 may be lightly screwed into the

rear of cannulated screw 90 and wire suture 55 threaded therethrough; thereafter, threaded collet 95 may be screwed further into cannulated screw 90 so that the nose of the threaded collet will close down on wire suture 55, whereby to clamp the wire suture to the threaded collet and, hence, to the cannulated screw.

Figs. 17, 20 and 21 show drivers for advancing and, alternatively, retracting cannulated screw 90 and threaded collet 95. More particularly, a first cannulated driver 135 is provided for turning cannulated screw 90. A second cannulated driver 140 is provided for turning threaded collet 95. Second cannulated driver 140 may be positioned within first cannulated driver 135, as will hereinafter be discussed.

In use, after wire suture 55 had been passed through angled tunnel 50, cannulated screw 90, threaded collet 95, second driver 140 and first driver 135 are mounted on the proximal end of wire suture 55 (Fig. 17). Next, the components are manipulated so

that threaded collet 95 is lightly threaded into cannulated screw 90, second driver 140 is engaged with threaded collet 95, and first driver 135 is engaged with cannulated screw 90. Then the aforementioned assembly is moved down wire suture 55 until the leading tip of cannulated screw 90 engages the femur, whereupon first driver 135 used to drive the cannulated screw into the femur. At this point, cannulated screw 90 will line angled tunnel 50, but wire suture 55 will be free to move relative to cannulated screw 90 and, hence, the patient's anatomy. Wire suture 55 is then used in the manner previously described to pick up graft ligament 25 and tow the graft ligament back up into position within the bone tunnel. Once the graft ligament is in position, wire suture 55 is made fast by screwing threaded collet 95 further into cannulated screw 90, using second driver 140, until the leading tip of the threaded collet closes down on wire suture 55, whereupon the wire suture will be clamped to the threaded collet and, hence, the cannulated screw. Once this has been

achieved, drivers 135 and 140 may be removed, the excess wire trimmed away, and the tibial side of the graft secured.

It should also be appreciated that the procedure and apparatus described above may be used for purposes other than an ACL repair, e.g., they may be used to repair other ligaments, the apparatus may be used in other types of surgical procedures such as trauma, spine, etc.

Also, the wire suture may be braided polyethylene or monofilament suture; and the cannulated screw and/or threaded collet may be plastic or even reabsorbable.